Evaluating the Performance and Effectiveness of Roundabouts

Presented by:

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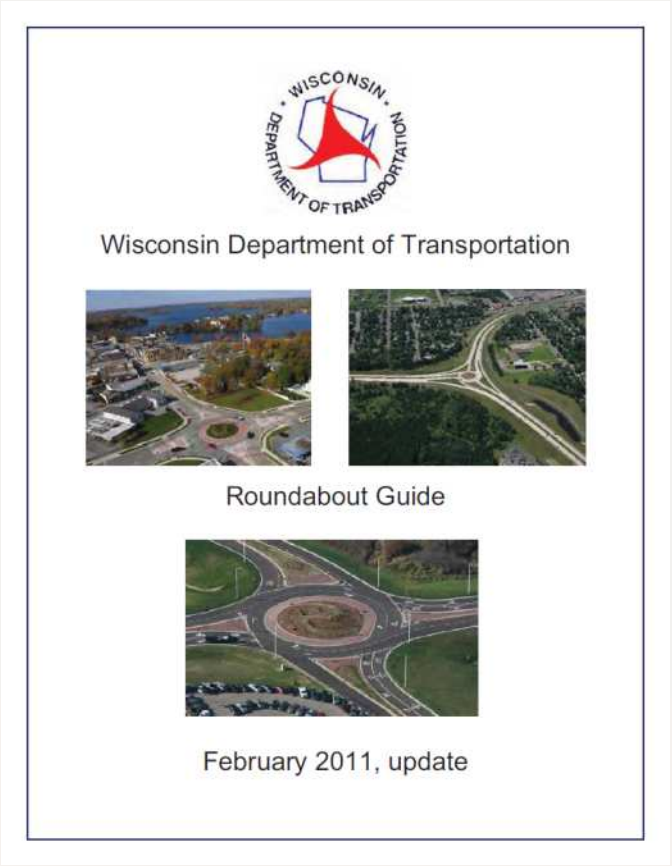
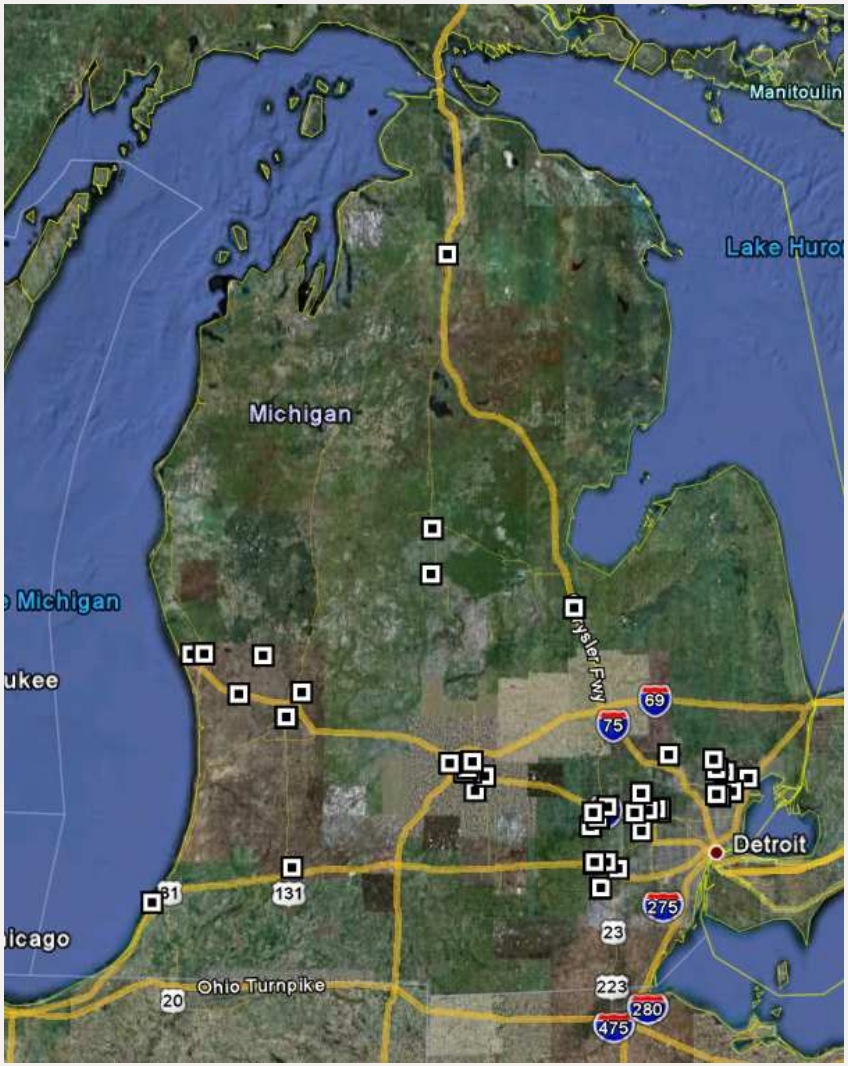
Study Objectives

- Determine the impact on crashes at locations where roundabouts have been installed
- Observe roundabout operations including truck maneuvers
- Identify the key geometric configurations and site characteristics that influence safety, performance and return on investment

Literature & Best Practices Review



Identify Roundabouts



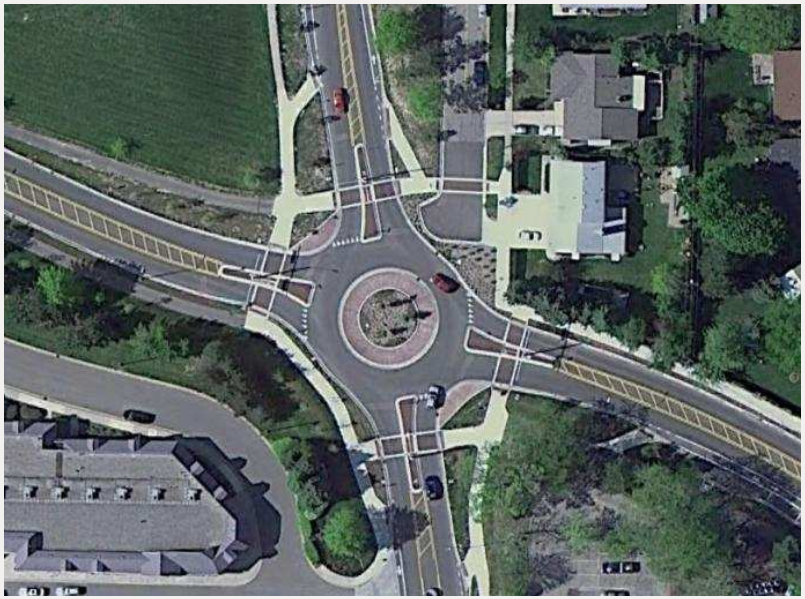
97 Roundabouts identified in Michigan

58 Roundabouts included in the analysis

- 47 Converted Sites
- 11 New Build Sites

15 sites - detailed reviews

Site Visits



- Walk-through
- Review of geometric design
- Observe operations
- Consider road user visibility at night
- Review truck turning maneuvers
- Review traffic control devices
- Treatment and transition of non-motorized facilities
- Modifications made by MDOT to roundabouts
- Traffic Counts
- Speed Studies

Traffic Conflicts

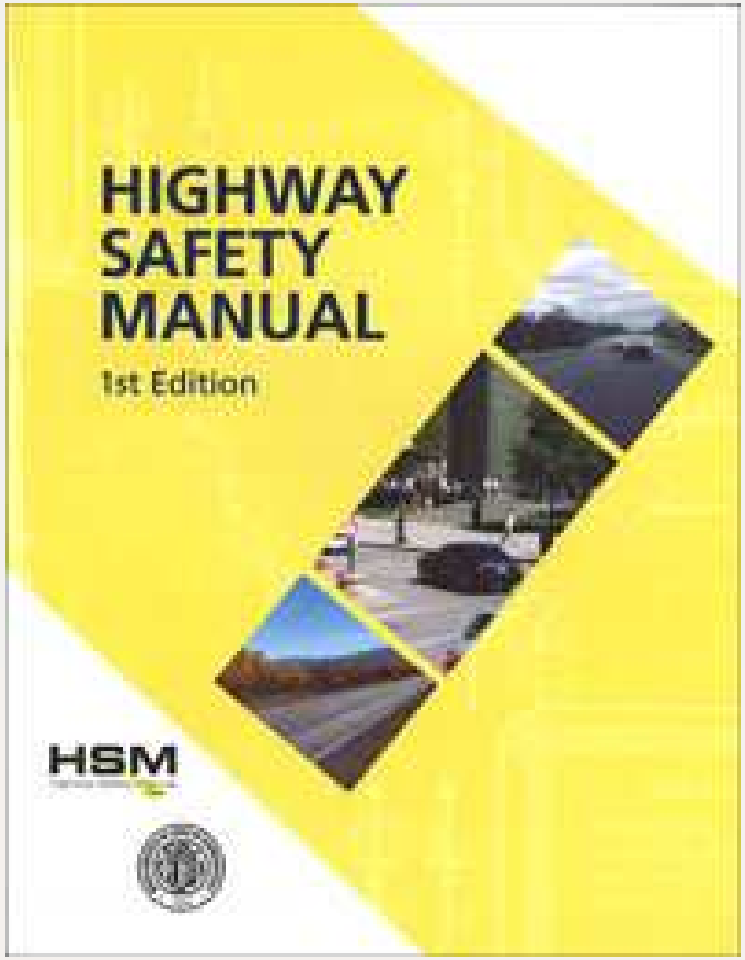
- "Near Misses"
- Key surrogate measure for safety performance
- Collected at following roundabouts;
  - M-47 & M-37
  - NB M-53 Ramp & 26 Mile
  - SB M-53 Ramp & 26 Mile
  - M-53/Van Dyke & 18 ½ Mile

Data Collection

- Crash data at treatment sites – before/after
- Crash data at reference sites – before/after
- Traffic Volumes - before/after
- Geometric and operational characteristics
- Implementation Dates

Safety Analysis

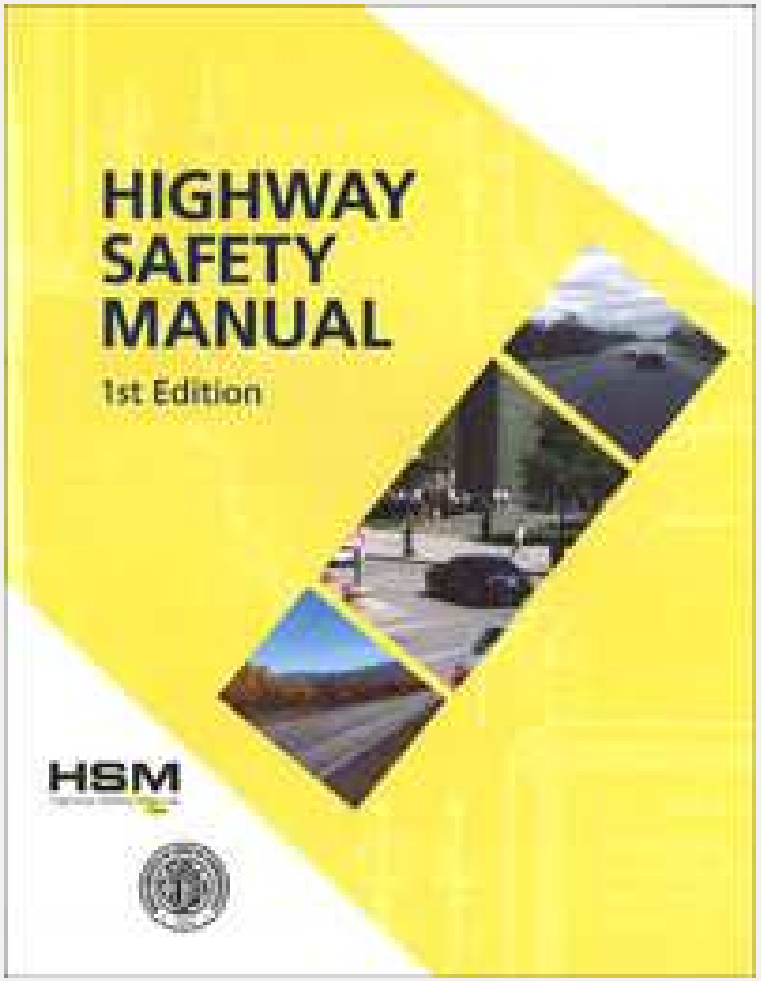
Develop Safety Performance Functions



- Utilized sites without roundabouts (stop/signal controlled, urban/rural) for the Empirical Bayes (EB) analysis
- Attempted to calibrate new SPFs with Michigan data, but was unsuccessful at a 90% confidence interval or greater
- Utilized the HSM calibration procedure to adapt *SafetyAnalyst* SPFs

Safety Analysis

Empirical-Bayes Analysis



- Estimates change in crashes by severity (total and fatal+injury crashes)
- Uses SPFs to account for regression-to-mean, crash trends, changes in traffic
- Scientifically rigorous – *SafetyAnalyst* and HSM Methodology

Safety Analysis

Two-Way Stop → Roundabout

US-127BR & Mission Street
Clare County

- Total Crashes=+9.5%
- Fatal & Injury Crashes=-42%

Safety Analysis

Two-Way Stop at Interchange → Roundabout

M-14 & Maple Road Interchange
Washtenaw County

- Total Crashes=+24%
- Fatal & Injury Crashes=-58%

Safety Analysis

Signal → Signal or Double Lane Roundabout

Utica & Dodge Park
Macomb County

- Total Crashes=-22%
- Fatal & Injury Crashes=-70%

Safety Analysis

Signal → Triple Lane Roundabout

14 Mile & Farmington
Oakland County

- Total Crashes+98%
- Fatal & Injury Crashes=-20%

Safety Analysis

Site Type by Condition before conversion	CMF	
	Total	Injury
All sites	1.346	0.583
All sites minus triple lane	1.002	0.488
One or two way Stop-controlled (All)	1.117	0.558
One or two way stop controlled at interchange	1.247	0.419
One or two way stop controlled not at interchange	1.095	0.581
All-way stop-controlled	1.026	0.636
Signalized (single and double lane roundabouts)	0.783	0.300
Signalized (triple lane roundabouts)	1.975	0.801

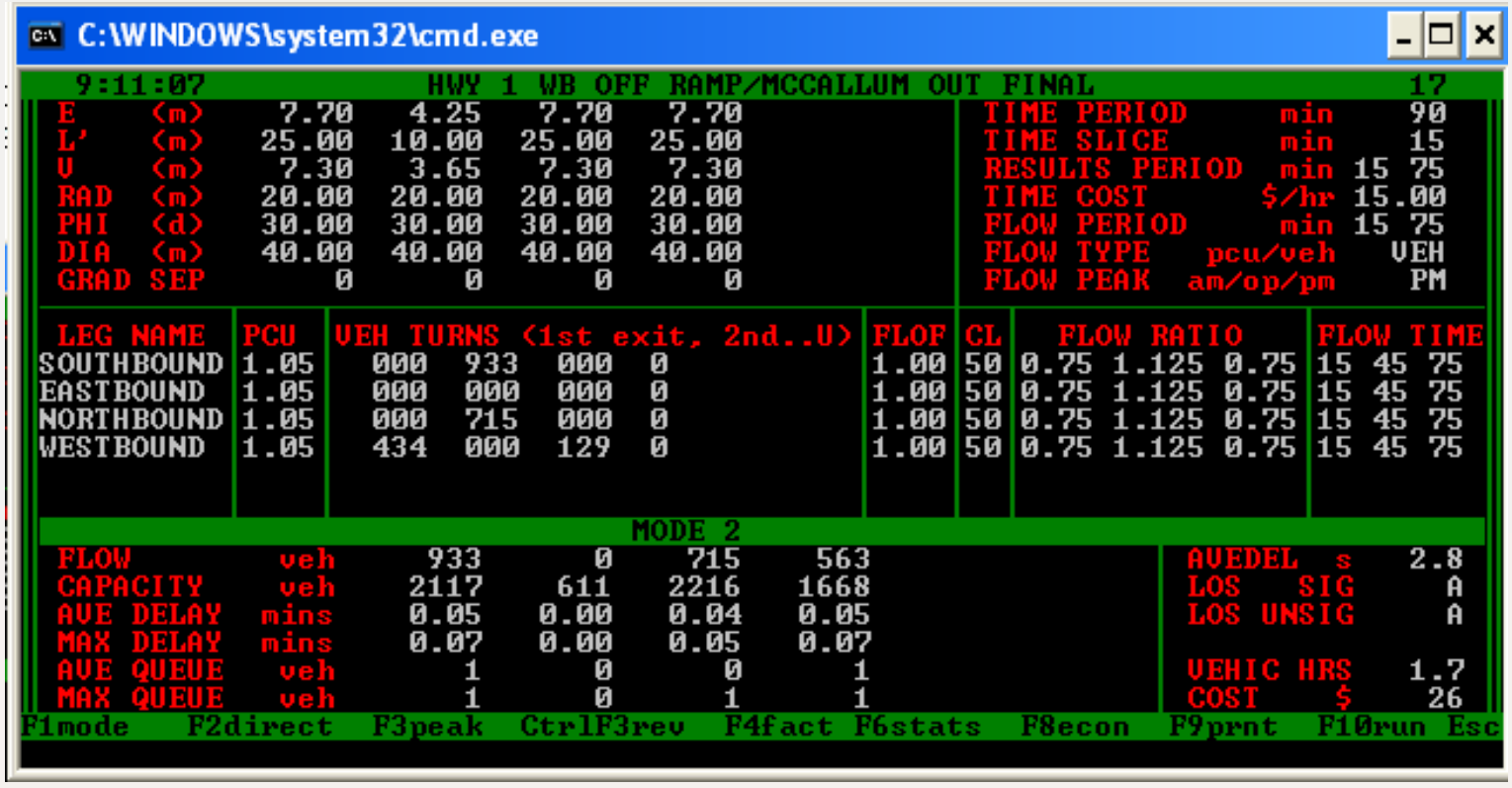
Safety Analysis

$$Crashes/year = exp^{\alpha}(AADT)^{\beta_1} exp^{(\beta_2 * Type + IC * \beta_3)}$$

Model	α (s.e.)	β1 (s.e.)	β2 (s.e.)	β3 (s.e.)	k (s.e.)
Total	1 lane -4.5958 (1.2851) 2 lane -3.8074 (1.2621)	0.5253 (0.1274)	-0.7884 (0.2423)	0.6988 (0.3710)	0.4839 (0.1266)
Injury	1 lane: -6.4109 (1.8322) 2 lane: -5.7287 (1.8066)	0.4788 (0.1795)	-0.6822 (0.3051)	0.7850 (0.5733)	0.2460 (0.1933)

Operational Analysis

Calculate change in LOS and delay at select treatment sites using RODEL software



Operational Analysis

AM Peak Period					
Intersection	"Before"		"After"		% change
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	
EB M-14 Ramps at Maple Road	F	105.5	A	6.5	93.8%
WB M-14 Ramps at Maple Road	D	34.2	A	5.1	85.1%
Huron Parkway at Nixon Road	B	22.3	A	5.7	74.4%
Maple Road at Drake Road	D	35.0**	A	5.7	83.7%
Maple Road at Farmington Road	F	80.0**	A	7.7	90.4%
** denotes an assumed value					

Operational Analysis

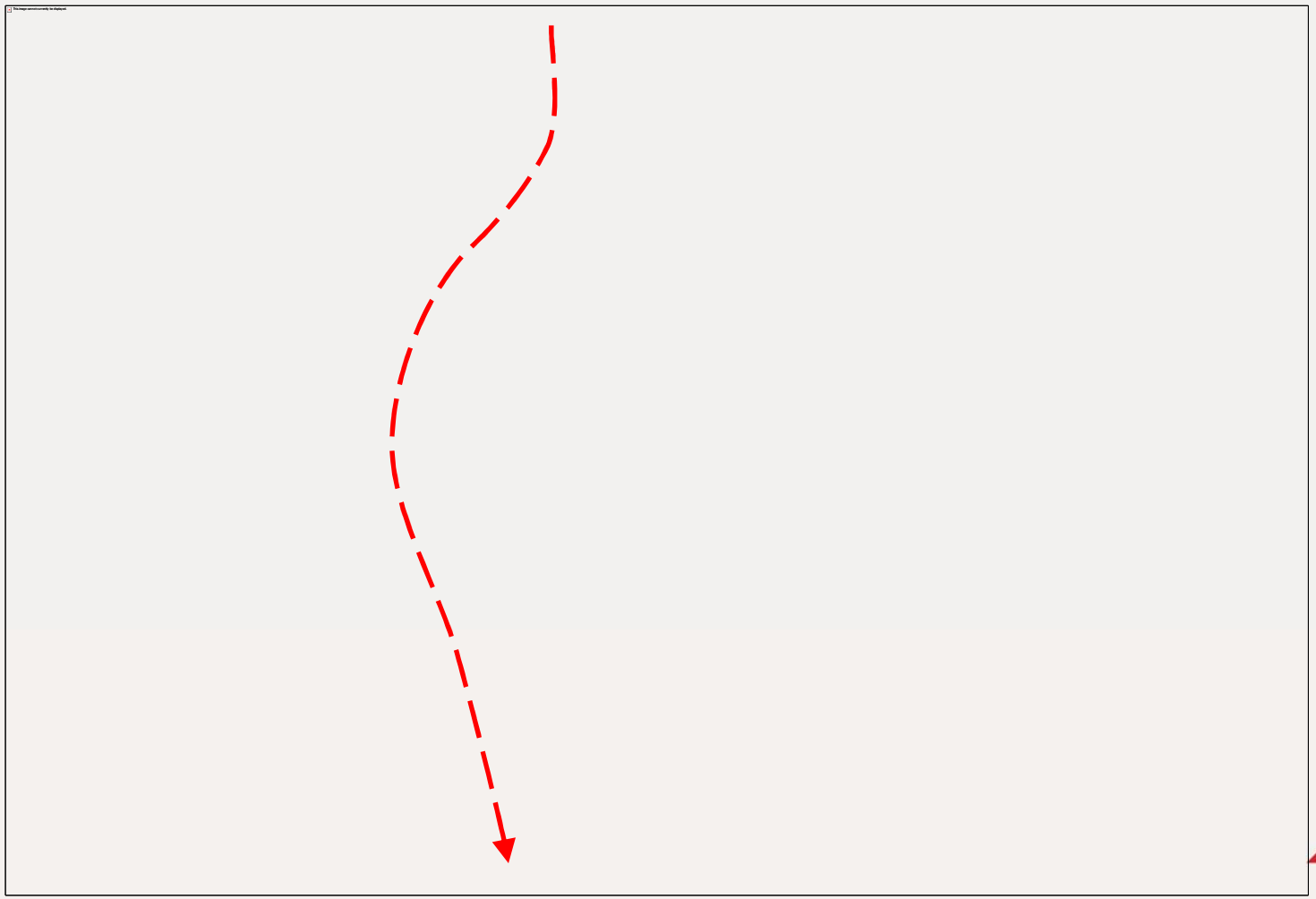
PM Peak Period					
Intersection	**"Before"**		**"After"**		**% Change**
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	
EB M-14 Ramps at Maple Road	E	37.1	A	6.5	82.5%
WB M-14 Ramps at Maple Road	C	16.0	A	3.7	76.9%
Huron Parkway at Nixon Road	B	19.5	A	6.8	65.1%
Maple Road at Drake Road	E	55.0**	A	6.4	88.4%
Maple Road at Farmington Road	E	55.0**	A	9.5	82.7%
** denotes an assumed value					

Economic Analysis

Type	Time of Return (years)
Single Lane Roundabout	0.8
Double Lane Roundabout	1.2
Triple Lane Roundabout	0.9

Findings

Lane Discipline → Higher Speeds

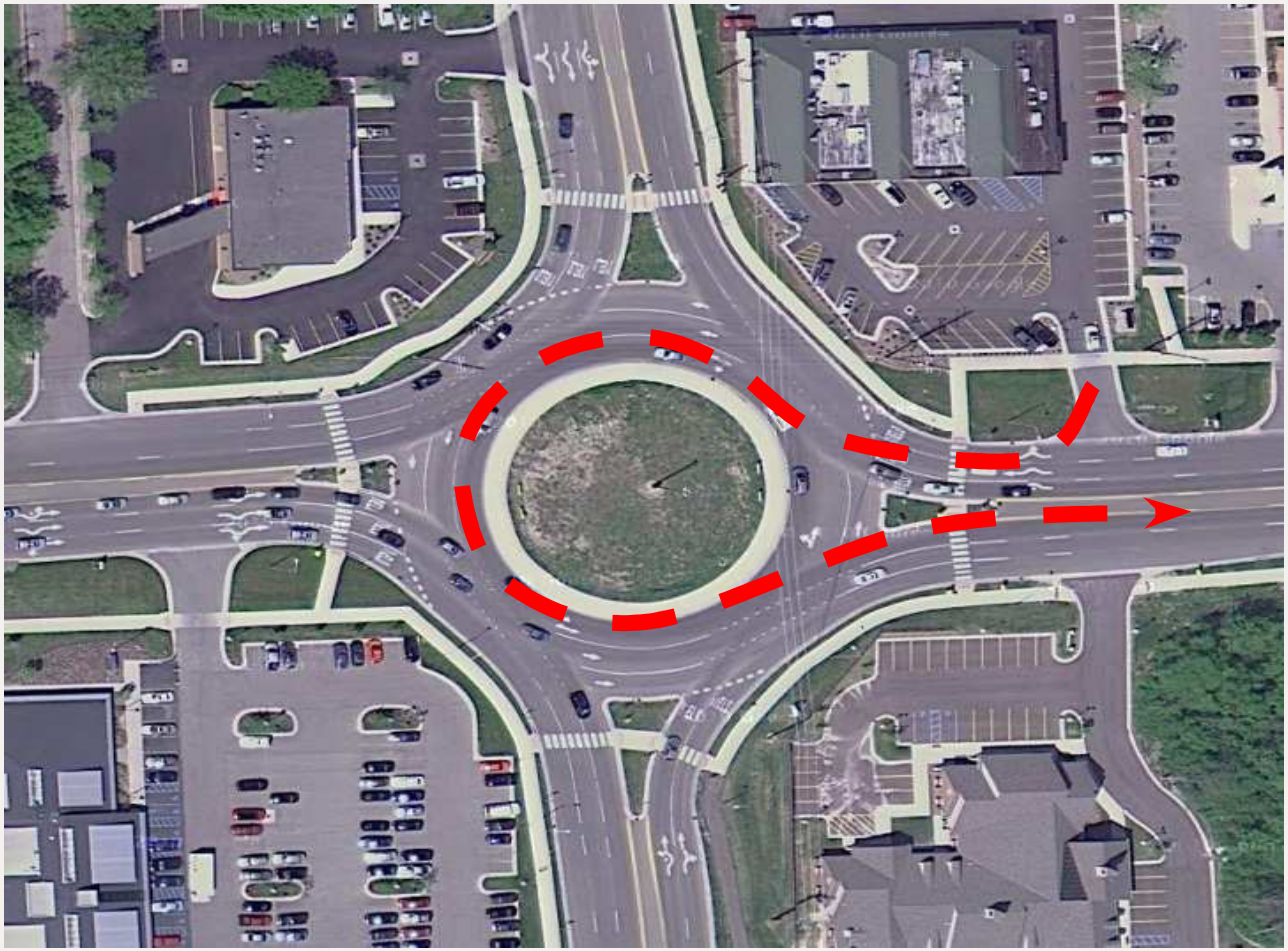


Findings

Merging on Exit Legs

Findings

Driveways Near Roundabouts



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